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LAYOUT FOR NOISE REDUCTION ON A PRINTED CIRCUIT BOARD AND CONNECTORS USING IT

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention is related to a layout on a printed circuit board for reducing noise or cross talk between two parallel-transmission signal conductors, especially to a printed circuit board can be used in a connector assembly with a conditioning parts including magnetic filter components mounted on the printed circuit board to condition the signals passing through the connector assembly.

2. Description of the related art

[0002] The digital communication between electronic device like computers becomes more and more important because of the prevalence of the Internet. People join a network to the Internet or a local area network through connecting cables or wireless equipments. However, before a better standards and reasonable price for wireless equipments can be established, the most important intermediary for people to connect to a network is still a cable/wire and the connector to mate with them. In high frequency and speed situation usually demanded by modern people, the reliability of signal transmission through these cables and connectors is very crucial to get a clear and precise signal after a long distance transmission. Usually the noise from the environment cables meet and cross talk between two parallel signal-transmitting conductors are the most undesired derivative in the

transmission. Therefore, if signals can be conditioned before they are received by any electronic device, the performance and working speed of this device will be fast and more accurate. A conditioning-use component, such as a common mode choke coil, filter circuit or transformer, can be mounted on a printed circuit board install inside an electronic device or an I/O connector of these devices. And the layout or conductive traces on/in the printed circuit board will helps to reduce or eliminate the undesired noise. In such a prior art electrical connector using differential signal pairs, the pair to pair cross talk which arises in cables or electrical connectors due to closely spaced elongated parallel conductors or contacts is reduced by modifying certain circuit paths either inside or outside of the connector. That means one each conductor of one pair which is parallel to and cross talking with an adjacent conductor of another pair is relocated adjacent and parallel to the other conductor of this another pair over a predetermined distance. So, the noise arisen in the connector by said conductor of the adjacent pair is compensated on the printed circuit board right away by the other conductor of the same adjacent pair. However, the arrangement is easy to achieve when two signal differential pairs are considered only. The more pairs are used, the more complicate compensating circuits on the printed circuit board are needed. Especially, as mentioned above, more than one conditioning electronic component is going to be mounted on the printed circuit board to condition the signals pass through them. And enough coupling distance of the adjacent pairs should be designed if significant electrical performance is demanded. It is obviously easily understood that more space on the printed circuit board will be needed to achieve these electrical performances. And the difficulty to assemble such a connector

will rise when a larger printed circuit board is adopted.

[0003] Using multi-layer printed circuit boards is one of the solutions to simplify the processes to make a miniaturized connector. But it costs expensive if a printed circuit board is designed to have too many necessary conductive layers to meet the need. Besides, it is difficult too if more than one connectors share the same printed circuit board serving as its conditioning part without increasing the size or layers of the printed circuit board. The copending application 10/041,101 having the same assignee with the invention, disclose some approach for implementation.

SUMMARY OF THE INVENTION

[0004] Therefore, an object of the present invention is to provide a layout of a printed circuit board to save space occupied by compensating circuits and avoid the need of increasing the size or layers of the printed circuit board.

[0005] Another object of the present invention is to provide a layout of a printed circuit board that has definitely and enough coupling areas for better compensating performance automatically before a preserved space is designed for this performance in advance.

[0006] Another object of the present invention is to provide a layout of a printed circuit board that can be used in common for at least two connecting portions to contribute to making a miniaturized and highly-integrated connecting

assembly.

[0007] A further object of the present invention is to provide a layout of a printed circuit board to reduce the possible noise between two differential signal pairs by separating them from each other as far as possible in the limited space of the printed circuit board.

[0008] To obtain the above objects, a printed circuit board includes a plane substrate having several insulated layers used to dispose with conductive material. A row of footprints used to connect to other electrical devices is disposed on an outer insulated layer of the printed circuit board. These footprints are paired and each is connected to a medial trace formed on one of the intermediate layers by a metalized hole. And the medial traces respectively connected to footprints of the same pair are formed on different intermediate layers and aligned with each other for a predetermined distance, so that these two traces of the same pair are moved closer to each other and far away from any other pair to stabilize their signal transmission.

[0009] Specifically, At least two traces connected to the chosen pair are detoured to pass through a corresponding area aligned with the footprints of their adjacent pair mounted on the upper face and are formed a corresponding footprint over there respectively, so that the corresponding footprint can be coupled with the footprints of the adjacent pair to improve the signals received by the chosen pair and its adjacent pair while the signals borne on these pairs of footprints are noised

each other due to closely spaced parallel transmission in said other electrical devices. To use the footprints for signal compensation instead of conductive traces benefits space-saving and miniaturization of a printed circuit board. Besides, to modify the size of the footprints for compensating according to the distance between the footprints and their coupling footprints will get better electrical performance.

[0010] Other objects, advantages and novel features of the invention will become more apparent from the following detailed description of the present embodiment when taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] FIG. 1 is a plane view of a printed circuit board in accordance with the present invention;

[0012] FIG. 2 is a sectional view of the printed circuit board showing conductors therein along the 2-2 line in FIG. 1;

[0013] FIG. 3 is a sectional view of the printed circuit board showing conductors therein along the 3-3 line in FIG. 1;

[0014] FIG. 4 is a plane view of a second printed circuit board in accordance with the present invention;

[0015] FIG. 5 is a sectional view of the printed circuit board showing conductors therein along the 5-5 line in FIG. 4;

[0016] FIG. 6 is a plane view of a third printed circuit board in accordance with the present invention;

[0017] FIG. 7 is a sectional view of the printed circuit board showing conductors therein along the 7-7 line in FIG. 6;

[0018] FIG. 8 is an explosive view of a multi-port connector assembly using a printed circuit board in accordance with the present invention as a part of its conditioning unit.

DESCRIPTION OF THE PREFERRED EMBODIMENT

[0019] Referring to FIGS.1, 2 and 3, the present invention is related to the layout on a printed circuit board 1 used to reduce noise. The printed circuit board 1 has a plane substrate 10 including at least three insulated layers to be disposed with conductive material, the outer ones formed as an upper face 11 and lower face 13, and intermediate layers 12. An insulative layer 14 is sandwiched between every two of the insulated layers. Besides, a row of footprints 2 used to connect to other electrical devices, especially referred to quadrate conductive pads, is disposed on the upper face 11 of the printed circuit board 1. According to the signal transmission frequency and speed standard, these connectable footprints 2 are arranged as several differential pairs. In this embodiment, the two footprints

T1, R1, T4, R4 at both ends of this row and the middle two footprints T3, R3 of this row are paired. And the remained footprints T2, R2, the third and sixth ones in the row, are paired. Each connectable footprint is integrally connected to a metalized hole 14 extending through the insulative layer 14 adjacent to the upper face 11 from the upper face 11 to one of intermediate layers 12 by a conductive trace 3 formed on the upper face 11. Meanwhile, the extending end of every metalized hole 14 is integrally connected to a medial trace 5 formed on one of the intermediate layers 12 to further connect to other portions of the printed circuit board 1 or electronic components mounted on the printed circuit board 1. Besides, footprints 2 of the same pair connect to one of medial traces 5 formed on different intermediate layers 12 respectively. For example, the footprint T1 (T2, T3, T4) of one pair connects to the medial trace C1 (C2, C3, C4) form on one intermediate layer 12 while the other footprint R1 (R2, R3, R4) of the same pair connects to the medial trace C1' (C2', C3', C4') of another intermediate layer 12. And portions of these paired two medial traces C1, C1' (C2, C2', C3, C3' and C4, C4') are aligned with each other over a predetermined length in the normal direction of intermediate layers. In the arrangement, the signal transmission paths for every differential pair T1, R1 (T2, R2, T3, R3, T4, R4) can be moved closer to each other and farther away from the transmission paths of any other pair. Thus the signal transmission for each differential pair is stabilized and less pair to pair noise will rise.

[0020] Referring to FIGS. 1 and 3, the medial traces 5 connect to a chosen pair (T3, R3 for example) are used to compensate the pair to pair noise which arises in

electrical devices like cables or electrical connectors due to their parallel arranged conductors. The traces C3, C3' connected to the chosen pair T3, R3 and extending from the end of their corresponding metalized holes 4 on the intermediate layers 12 are detoured to pass through a corresponding area next to footprints 2 of the adjacent pair T2, R2 mounted on the upper face 11 and are formed with corresponding footprints R3', T3' over there. The corresponding footprint R3', T3' connected to the chosen pair R3, T3 is parallel to the footprint of the adjacent pair T2, R2 and signals passing through the footprints T2, R2 can be compensated due to coupling with the footprints T3, R3', R3, T3' of the chosen pair at the same time. It is understandable that only the neighborhood area of the footprints 2 is occupied by compensating circuits. And the predetermined length of every footprint 2 needed to connect to the corresponding conductors of the electrical devices is long enough for better compensating performance. Therefore space-saving and miniaturization of a built-in printed circuit board can be easily achieved.

[0021] Referring to FIG. 8, a built-in printed circuit board 1 in accordance with the present invention is installed in a connector assembly 6. The connector assembly 6 has two stacked mating ports formed by an integrated housing 60. The printed circuit board 1 is inserted into the housing 60 from its rear side and positioned in its middle portion. Two terminal modules 62 with insert-molded terminals for mating are mounted and soldered onto both sides of the printed circuit board 1 near its insertion leading edge. And two corresponding conditioning components 63 and tail module 64 are mounted onto the printed

circuit board 1 respectively to form a conditioning unit 61 before assembling. It is obvious the size and price of the printed circuit board 1 is a key to the relative size and cost of this connector assembly. And the layout of the printed circuit board will be simplified in accordance with the present invention by repeatedly using the footprints 2 where the terminals of the connector assembly 6 are soldered and separating the compensating circuits from the traces connecting to the conditioning components 63 and tail module 64.

[0022] Referring to FIGS. 4 and 5, a second embodiment of the printed circuit board in accordance with the present invention is shown. An enlarged footprint R3", T3" instead of the footprint R3', T3' having the same size as footprint 2 is respectively formed along the traces C3, C3' on intermediate layers 12 which are connected to the chosen pair T3, R3 and detoured to pass through a corresponding area next to footprints 2 of the adjacent pair T2, R2. Better electrical performance will be achieved because a larger coupling area is available respectively with the enlarged footprint R3", T3" and the adjacent pair T2, R2 to assure of complete noise compensation.

[0023] Referring to FIGS. 6 and 7, a third embodiment of the printed circuit board in accordance with the present invention is shown. The trace C3 on the intermediate layer 12 right next to the upper face 11 of the substrate 10 has a compensating footprint R3' formed on the corresponding parallel area of the intermediate layer 12 to one of the footprints 2 of the pair T2, R2 on the upper face 11, and the compensating footprint R3' has the same size as its coupling footprint

T2 of the pair T2, R2. Besides, the trace C3', which is on the intermediate layer 12 right next to the lower face 13, has an enlarged footprint T3" formed on the corresponding parallel area of this intermediate layer 12 to the other footprint R2 of the pair T2, R2. The size of the compensating footprints R3' and T3" is decided by the distance between the intermediate layers 12 they are mounted and the upper face 11 where their coupling paired footprints T2, R2 are mounted. The coupling footprints R2, T3" having a larger distance therebetween are designed to have an enlarged compensating footprint T3". Better electrical performance than fore-mentioned two embodiments will be achieved while not only a larger coupling area is available from the enlarged footprint T3" and its coupling footprint R2 but also a new balance of signal compensation between these coupling pair R2, T3" and T2, R3' will be established.

[0024] It is to be understood, however, that even though numerous characteristics and advantages of the present invention have been set forth in the foregoing description, together with details of the structure and function of the invention, the disclosure is illustrative only, and changes may be made in detail, especially in matters of shape, size, and arrangement of parts within the principles of the invention to the full extent indicated by the broad general meaning of the terms in which the appended claims are expressed.